EXHIBIT 4

ADVANCE COPY

MIL-M-15071D(SHIPS)
6 June 1961
SUPERSEDING
MIL-M-15071C(SHIPS)
10 September 1957

MILITARY SPECIFICATION

MANUAL, SERVICE (INSTRUCTION BOOKS) FOR SHIPBOARD ELECTRICAL AND MECHANICAL EQUIPMENT

1. SCOPE

1.1 Scope. - This specification sets forth Bureau of Ships requirements for classes and general contents of manuals necessary for the satisfactory operation, maintenance, installation, overhaul and repair, without the services of manufacturer's representative, of electrical, mechanical, hull, interior communication and fire control shipboard equipment. This specification also includes procedures for submission, review, approval and revision of the service manual. The intent is to accept the manufacturer's commercial type of manual or one prepared in accordance with his commercial practice whenever it is roughly equivalent to the detail requirements included herein.

1.2 Classification. - Service manuals shall be of the following classes:

Class A manual - A basic manual covering a family of equipment of the same basic design and one which can be made applicable to a specific equipment manufactured to that basic design by completing sheets and blanks.
Class B manual - A manual covering a specific equipment for which a class A approval has not been obtained.

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids, form a part of this specification to the extent specified herein.

SPECIFICATIONS

MILITARY
MIL-D-963 - Drawing, Electrical, Hull and Mechanical Equipment for Naval Shipboard Use.

FSC 7610

PUBLICATIONS

DEPARTMENT OF DEFENSE
DD Form 441 (Attachment) - Industrial Security Manual for Safe-guarding Classified Information.

(Copies of specifications and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 The following document forms a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids shall apply.

OFFICIAL CLASSIFICATION COMMITTEE
Uniform Freight Classification Rules.

(Application for copies should be addressed to the Official Classification Committee, 1 Park Avenue at 33rd Street, New York 16, N. Y.)

3. REQUIREMENTS

3.1 Media for final manuals and approval. -

3.1.1 Class A manuals. - Whenever a manufacturer's equipment lends itself to the preparation of a manual covering a family of equipments of the same basic design and one which can be made applicable to specific equipments of that design by completing sheets and blanks, the manufacturer may submit to the Bureau of Ships four copies of the basic manual together with examples of the sheets and blanks which will represent the detailed information to be provided for a specific equipment. Approval of a class A manual will be by the Bureau of Ships only and, once approved, the basic manual shall not be modified without the approval of the Bureau of Ships. At the time of class A manual approval, the Bureau will assign a NAVSHIPS number to the basic manual and forward one copy to the cognizant inspector for future comparison inspection with manuals furnished for specific equipments.

3.1.1.1 Once approval of a class A manual is granted for a particular basic design of equipment (and size range, if appropriate), the basic manual with the specific detailed information required for the unit of the family being furnished on a contract or order may be supplied by the manufacturer, in the quantities required by that order, without further approval. Copies of the manual prepared for the specific equipments shall be marked by the manufacturer with the NAVSHIPS number of the basic manual followed by "-1", "-2" or higher. Each dash number shall be assigned numerically by the manufacturer for each specific equipment of that family.

3.1.2 Class B manuals. - Class B manuals cover a specific equipment for which class A approval has not been obtained. Once a class B manual has been approved by the Bureau or its field representative, the manual shall not be modified without approval of the Bureau of Ships. (NOTE: Bureau of Ships field representative - Where the term "field representative" is used in this specification, it is limited to field representative of the Bureau of Ships, i.e. Supervisors of Shipbuilding, USN, U.S. Naval Shipyards and Industrial Manager, USN.) Whenever a manual for a specific equipment has not been approved previously, for this or a previous issue of this specification, prior to preparing final manuals, the manufacturer shall prepare and submit a sample manual for approval to one of the following activities, as appropriate:

(a) Manuals procured on Bureau of Ships contracts - Contractor shall forward four sample copies to the Bureau of Ships for approval and assignment of a NAVSHIPS number with a copy of the forwarding document to the cognizant Government inspector.
(b) Manuals procured on contracts issued by Naval activities other than Bureau of Ships - Contractor shall forward four sample copies to the Naval activity for approval.
(c) Manuals procured for the Navy by a commercial activity (such as a private shipbuilder) - Contractor shall forward five sample copies to the commercial activity for approval of both the commercial activity and the cognizant Bureau representative.

3.1.2.1 The Bureau will assign a NAVSHIPS number to each different class B manual as follows:

(a) Manuals procured on contracts issued by the Bureau of Ships - The NAVSHIPS number will be included in the approval letter.
(b) Manuals procured on contracts issued by other activities.

The field approving activities may obtain NAVSHIPS numbers from the Bureau of Ships by one of the following methods:

(a) Submit two copies of the manual prior or subsequent [redacted] to the review and approval.
(b) Permit the manufacturer to forward two copies of the manual to the Bureau simultaneously with the copies for approval.
(c) In urgent cases, submit a letter containing the nameplate data of the equipment, the ship applicability and contract or order number.

3.1.2.2 Regardless of the method used for obtaining NAVSHIPS numbers, the letter request shall state the expected delivery date of the manuals and the quantity of manuals being furnished for stock.

3.1.3 Emphasis. - The Bureau of Ships is mainly interested in the adequacy and completeness of contents and the clarity and readability of the information rather than the format. The manual shall be oriented toward operation, maintenance and repair of the equipment by the forces afloat, without the services of a manufacturer's representative. The portions devoted to descriptive matter and theory shall be limited to those which are essential to a proper understanding of the equipment for satisfactory operation, maintenance and repair. The text need not duplicate information which is adequately shown on the photographs, drawings and illustrations incorporated in the manual. (A class A or B manual may be the manufacturer's commercial manual, or one prepared in accordance with his commercial practice whenever it will be suitable for the service intended as determined by the approving activity.)

3.1.4 Security classification. - The security classification of manuals shall be as designated by the bureau or agency concerned. If classified, the security guide issued by DD form 254, forming a part of the contract shall be followed. All pages shall be marked in accordance with the requirements of the Industrial Security Manual for Safeguarding Classified Information (DD 441 (Attachment)). Where a minor amount of classified information is involved, two volumes - one unclassified and one classified shall be provided. The word "UNCLASSIFIED" need not appear on each page of unclassified portions of classified manuals. Revisions shall be classified as required by their subject matter. Regardless of the overall classification of a classified publication, an unclassified title shall be assigned whenever possible and consistent with security and clarity. In all cases, however, if a classified manual is involved, the initials of the classification assigned to the title, standing alone, shall be indicated in parentheses immediately following the title, using one of the following notation (U), (C), (S), (TS). In addition, the covers of classified manuals shall include the markings as indicated on figure 1.

3.1.5 Detail requirements. -

3.1.5.1 Contents. - Manuals shall contain the following information, arranged in an order appropriate to provide adequate instruction for operation and maintenance of each unit in the equipment and the complete assembly: No particular arrangement, format or chapter titles are required as long as the information is suitably presented.

Front Matter
General Information
Installation
Principles of Operation
Operating Instructions
Maintenance and Repair
Parts Lists

3.1.5.2 Front matter. - The front matter shall consist of the following:

(a) Cover
(b) Title page (for classified manuals only)
(c) Approval and procurement record page
(d) List of effective pages
(e) Table of contents
(f) List of figures
(g) List of tables

3.1.5.2.1 Cover and title page. - The cover shall contain the information on figure 1. The title page for classified manuals shall conform to figure 2.

3.1.5.2.2 Approval and procurement record page. - The approval and procurement record (APR) page shall be the first page of unclassified manuals and shall follow the title page of classified manuals and shall conform to figure 3.

3.1.5.2.3 List of effective pages. - A list of effective pages shall be included. In multiple volume manuals, the list of effective pages shall be included in volume 1 only. The list of effective pages shall be modified whenever revisions are incorporated in copies of the manual.

3.1.6.2.4 Table of contents. - The table of contents shall list all primary divisions and secondary subdivisions such as chapters, sections and pages with their corresponding numbers. Where sub-manufacturers are furnishing associated equipment and a separate manual is not provided, it shall be the responsibility of the prime contractor to integrate and reflect the information provided by the sub-manufacturers within the table of contents. In multiple volume publications, a table of contents shall be prepared for each volume.

3.1.6.2.5 List of figures. - A list of figures shall be prepared listing all figures, their titles and numbers. In multi-volume publications, a list of figures shall be prepared for each volume.

3.1.6.2.6 List of tables. - A list of tables shall be prepared listing all tables, their titles and numbers. In multi-volume publications, a list of tables shall be prepared for each volume.

3.1.6 General information. - General information shall consist of general data, a general description and detailed descriptions, as necessary to supplement data included in drawings and photographs.

3.1.6.1 General data. - General data shall consist of the following data for each component or unit:

(a) Descriptive (name plate) data necessary to identify manufacturer, type, model and performance or design characteristics.
(b) Principal overall dimensions.
(c) Weight.
(d) Allowable capacities, temperatures, pressures, settings, tolerances or other salient features as appropriate to the item shall be shown.

3.1.6.2 General description. - General description shall consist of a short general description of the equipment; explain briefly what it is, what it will do, and the general overall and interrelated operation of the various units. All information of a general character applicable to the complete equipment shall also be given. Where the text contains terms or symbols not commonly used, definitions or explanatory notes shall be included.

3.1.6.3 Detailed description. - Detailed description shall contain a complete detailed description of units and assemblies which comprise the complete equipment; for example: ship service turbo generator: the turbine, reduction gear, generator and exciter.

3.1.7 Installation. - Instructions, if necessary to supplement the installation drawings supplied (in accordance with Specification MIL-D-963), shall consist of methods of installation; including packing or unpacking, handling, preparation of foundation, alignment, precautions, mounting instructions, bolting diagrams, safety guards, grounding or bonding, clearances for access, ventilation, motion under shock, and methods of testing to assure satisfactory installation.

3.1.8 Principles of operation. - Figures, sketches, performance curves, and schematic wiring diagrams shall be included to the extent necessary to provide satisfactory operation, maintenance and repair. Operating sequences of automatic and semi-automatic equipment shall be indicated.

3.1.9 Operating instructions. - Information shall include routine and emergency procedures, and safety precautions; maximum and minimum loads; normal temperatures or pressure limits or both; transfer from manual to automatic operation (or the reverse), to be observed in the starting, operating, stopping, and shutting down of the equipment. In addition, action(s) which should be taken in the event of power failure; control air failure; lube-oil failure; partial failure of equipment; and similar conditions shall be described. Action(s) described in the event of partial failure shall include, where practicable, those procedures necessary to provide continued service of the equipment until time is available to repair the equipment. Where operating procedures are to be performed in specific sequence, step-by-step procedures shall be given. Operations shall be numbered in the order in which they are performed. Tables and charts shall be used for the presentation of these instructions where varying operating conditions are encountered.

3.1.10 Maintenance and repair. -

3.1.10.1 Preventive maintenance. - Instructions shall include all maintenance procedures, inspections, tests, and adjustments which should be performed periodically under shipboard conditions for the purpose of preventing failure or impairment of the equipment. A one page summary and time schedule for maintenance procedures, including a check-off table where appropriate, shall be provided. The summary sheet shall identify any items required by the Navy, as indicated at time of approval action, to be included in the ship's permanent history cards. Where necessary instructions shall include procedures for obtaining access to the sub-components for maintenance. Maintenance instructions shall include, where appropriate, but shall not be limited to the following:

(a) A tabulation of periodic, routine, mechanical, and electrical tests and checks which should be accomplished regularly to show that sub-components are operating properly and to insure continuity of service at optimum performance.
(b) Table or charts, including "wear-limit" charts when appropriate, to indicate what is to be done, when it is to be done based on inspection, and how to do it.
(c) Utilization of the test facilities which may be incorporated in the various components.
(d) Instructions for the care, inspection, and cleaning of all pertinent parts.
(e) Instructions stressing the importance of properly maintaining all safety devices and interlocks provided to prevent damage to equipment or injury to personnel.
(f) Instructions on lubrication at shipboard operating temperatures shall be provided as applicable, preferably in chart form. They shall include information regarding lubrication recommended by the manufacturer and the type of lubricant to be used. Lubricants shall be described by symbol number, Federal stock number, Military specification and industry standard numbers where applicable and known.
(g) Instructions on in-place-balancing or other means of reducing noise level if equipment specifications and shipboard application require quiet operation.

5.1.10.2 Trouble shooting, overhaul and repair. - Instructions shall include all information necessary to permit a technician to locate trouble, and to make repairs, adjustments and conduct tests of each component, assembly or sub-assembly of the equipment. The following shall be included:

(a) Trouble shooting guides for the localization of faults giving possible sources of trouble, the symptoms, probable cause, and instructions for remedying the faults.
(b) Complete instructions on signal tracing for electric circuits, use of special test instruments and unusual servicing techniques.
(c) Ample figures and sectional views giving details of mechanical assemblies, and simplified schematic diagrams of electrical, mechanical, hydraulic and pneumatic circuits. Figures contained elsewhere in the manual may be used and referred to under this heading without duplicating them.

3.1.11 Parts list. - The parts list shall include identification data covering all repair parts to facilitate ready identification of parts for replacement and ordering purposes. Standard hardware, structural parts, or other parts which have no maintenance significance shall not be listed.

3.1.12 Special tools. - A separate list of "special tools" which are supplied with the equipment shall immediately follow the parts tabulation; this list shall contain only tools that are peculiar to the equipment showing the quantity, unit of issue (each, pair, set), description, and manufacturer's identification number. A photograph or sketch showing each special tool as it is being used, shall be included in the manual.

3.1.13 Photographs and drawings. - As the preferred alternate to lengthy, detailed discussions, the manual shall make maximum use of shop photographs, with parts annotated for identification. Photographs may be half-tones or glossy prints. Manuals shall contain reproductions of drawings, additional block diagrams and schematic drawings as necessary to supplement the descriptive matter contained in the text. In every case, a drawing or photograph of the assembly shall be included. Diagrams of switches and relays used in the system showing the terminal numbering shall be inserted as additional drawings. Photographs and sketches shall be included wherever necessary for identification of the parts in the "parts list". Other figures shall be included to supplement or extend the information contained in the photographs and drawings as required for further identification of parts and explanation of the descriptive information contained in the text.

3.2 Format. -

3.2.1 Volumes. - Manuals shall be divided into volumes and by chapters or sections as necessary to provide ready handling and to present orderly instructions for operation and maintenance of the equipment, depending on the size and complexity of the manual.

3.2.2 Numbering. - Any section, chapter, page and paragraph numbering system which facilitates adequate indexing and rapid location of pertinent information is acceptable.

3.3 Text. -

3.3.1 Wording. - The text shall be factual, specific, concise, and clearly worded to be readily understandable by personnel involved in the operation, repair, overhaul and maintenance of the equipment, and to provide sufficient information for technicians to install, operate, service, and maintain the equipment at peak performance without the services of a manufacturer's representative. Technical phraseology requiring a specialized knowledge shall be avoided except where no other wording will convey the intended meaning, in which case the technical term shall be defined.

3.3.2 Level of writing. - As a general guide, the level of writing should be that for a high school graduate having specialized training as a technician through Navy training courses.

3.3.3 Figures. - Sectional views of assemblies, sub-assemblies and the component parts thereof shall be shown as necessary to supplement the text, photographs, and drawings and aid in the identification of parts. Identification of illustrated parts with listed parts shall be facilitated by the use of index (or piece) numbers and arrows which will identify assemblies, sub-assemblies and component parts thereof.

3.3.4 Indexing and referencing of figures. - Significant features or components of figures shall be identified by brief applicable nomenclature with arrows. Index (or piece) numbers may be used on figures when an extremely large amount of nomenclature is required.

3.3.5 Deleted figures. - When a change requires deletion of a figure without substitution of another, the following sentence shall be inserted "Figure ____ deleted" in or near the place of deletion.

3.3.6 Notes, cautions and warnings. - Notes, cautions and warnings should be used to emphasize important and critical instructions. The use should be as sparing as is consistent with real need. When used, notes, cautions and warnings should immediately precede the applicable instructions and shall be selected in accordance with the following definitions:

(a) "NOTE" - An operating procedure, condition, etc., which it is essential to highlight.

(b) "CAUTION" - Operating procedures, practices, etc., when if not strictly observed, will result in damage or destruction of equipment.

(c) "WARNING" - Operating procedures, practices, etc., which will result in personal injury or loss of life if not correctly followed.

3.4 Applicability of manuals. -

3.4.1 Identical. - When a class A manual covering a specific equipment or a class B manual which is already available, is applicable in its entirety to the equipment being procured, the applicability is to be extended to include the additional ships by the manufacturer issuing an approval and procurement record page. Copies of the manual required for the ship(s) and local use may be requisitioned from stock by the cognizant Naval supervising activity.

3.4.2 Identical except for minor modifications. - When a class A manual covering a specific equipment or a class B manual is applicable to the equipment being procured except for minor differences, the manufacturer shall modify the manual to cover the differences by the issue of revised or supplementary pages. All revisions to an existing manual shall be approved by the Bureau of Ships, shall require the assignment of a change number, assigned by the Bureau of Ships, and shall be issued by the manufacturer with an approval and procurement record page.

3.5 Revisions. - Revisions to manuals which have been previously distributed shall be prepared as follows:

(a) New pages - New pages shall be issued when it is found necessary to include new information to augment the content of the original manual.
(b) Revised pages - Revised pages shall be issued to make changes which apply uniformly to all equipments covered by the manual.
(c) Supplementary pages - Supplementary pages shall be issued when necessary to provide alternate instructions applicable only to a portion of the total equipments covered by the manual because of minor modifications or minor differences in related components.

3.5.1 Legend for revisions. - All new, revised or supplementary pages shall include the words "new", "revised" or "supplementary", the date and a change number.

3.5.2 Submission for approval. - Four copies of each revision shall be submitted to the Bureau for approval and assignment of a change number. The forwarding letter shall include the number of stock copies and the estimated delivery date of the final copies.

3.6 Production requirements. --Details of materials, printing procedures and assembly for each manual shall be as approved at time of class A or B manual approval. An acceptable arrangement is set forth in the appendix of this specification. Alternate arrangements will be approved if equivalent performance is provided.

3.7 Distribution requirements. - Unless otherwise specified in the contract or order, distribution of all manuals not exactly identical to one previously procured and assigned a NAVSHIPS number shall be as follows:

(a) Two copies for each equipment shall be packed with the equipment when the equipment is shipped to stock.
(b) Two copies for each equipment shall be shipped separately to the cognizant Naval supervising activity marked for each ship on which the equipment is to be installed.
(c) Two copies to the Bureau of Ships.
(d) Three copies to the cognizant Supervisor of Shipbuilding when the equipment is to be installed by a private shipyard. (These copies are in addition to the copies for placement on board the ship.)
(e) Two copies to the Naval shipyard when the equipment is to be installed by that activity. (These copies are in addition to the copies for placement on board the ship.)
(f) One copy to each U.S. Naval Shipyard except Pearl Harbor and Portsmouth Naval Shipyard (total of nine).
(g) Two copies to Pearl Harbor Naval Shipyard (for submarine and surface ship equipment).
(h) Two copies to Portsmouth Naval Shipyard (for submarine equipment only).
(i) One copy to all active submarine tenders (submarine equipment only).
(j) One copy to Submarine Bases, New London and Pearl Harbor (submarine equipment only).
(k) Two copies to Commanding Officer, Ships Parts Control Center, Mechanicsburg, Penn.
(l) One copy to Naval Supply Centers, Norfolk and Oakland.
(m) One copy to Naval Supply Depot, Clearfield, Odgen, Utah.
(n) One copy to Forms and Publications Supply Office, Byron, Georgia.

(c) Manuals for stock shall be in the following quantities:

Number of equipments	Number of copies
1 to 25	25
26 to 99	50
100 and over	100

These manuals shall be shipped to:
Receiving Officer, Naval Supply Depot, Mechanicsburg, Penn.
Marked for COG I stock.

(p) Copies of approval and procurement record pages in accordance with paragraph 3.10.

3.8 Unless otherwise specified in the contract or order, (where manuals are not to be drawn from stock, see 3.4.1) distribution of all manuals exactly identical to ones previously approved shall be as follows:

(a) Two copies for each equipment shall be packed with the equipment when the equipment is shipped to stock.
(b) Two copies for each equipment shall be shipped separately to the cognizant Naval supervising activity marked for each ship on which the equipment is to be installed.
(c) Copies of approval and procurement record pages in accordance with 3.10.

3.9 Revisions. - Revision pages shall be distributed to all activities receiving the original manual, and in the same quantity.

3.10 Approval and procurement record page. - This page shall be included in all copies of the manuals and additional copies distributed as follows:

(a) Two copies to Bureau of Ships.
(b) One copy to Forms and Publications Supply Office, Byron, Georgia.
(c) One copy to Ships Parts Control Center, Mechanicsburg, Penn.

3.11 Military Assistance Program Ships. - Unless otherwise specified in the contract or order, distribution of all final manuals for ships being constructed, reactivated, converted or otherwise readied for transfer under the Military Assistance Program (MAP) shall be as follows:

(a) Two copies for each equipment shall be shipped separately to the cognizant Naval supervising activity marked for each ship on which the equipment is to be installed.
(b) Six copies per equipment for each ship to be transferred under MAP to a foreign government. These copies shall be sent to the Military Assistance Advisory Group (MAAG) of the recipient country for delivery to the foreign government which is to receive the ships.
(c) One copy to the Washington, D. C. Naval Attache of the foreign government to receive the ships.
(d) Two copies to the Bureau of Ships.
(e) One copy to the cognizant Supervisor of Shipbuilding when the equipment is to be installed at a private yard.
(f) One copy to the Commanding Officer, U.S. Navy Forms and Publications Supply Office, Byron, Georgia.
(g) Twelve copies to Receiving Officer, U.S. Naval Supply Depot, Mechanicsburg, Penn., marked for COG I stock.

4. QUALITY ASSURANCE PROVISIONS

4.1 Contractor responsibility. - The supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own or any other inspection facilities and services acceptable to the Government. Inspection records of the examinations shall be kept complete and available to the Government as specified in the contract or order. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Inspection. - Sample copies shall be inspected to determine compliance with the requirements of this specification and for equivalence with the approved (when applicable) sample or basic manual. (If any subsequent issue of manuals is not equivalent to or better than an approved class A manual, class A approval may be withdrawn.)

4.3 Content. - The content of the manual shall be checked against the equipment being furnished to assure that it depicts accurately and adequately the equipment and the operating and maintenance procedures required. The NAVSHIPS number on the manual shall be checked for agreement with the NAVSHIPS number on the equipment identification plate where specified.

5. PREPARATION FOR DELIVERY

5.1 Packaging and packing. -

5.1.1 Individual and multi-volume manuals. - Individual copies and multi-volume manuals shall be packed to preclude damage to material. Multi-volume manuals shall be furnished as complete sets.

5.1.2 Manuals shipped with equipment. - When two copies of the manual are packed with the equipment they shall be packed within the shipping container holding the main unit of equipment. The manual(s) shall be so placed that they are readily accessible prior to removing the equipment and shall not be placed within the vaporproof barrier material used to enclose the equipment. Manuals accompanying equipment shall be packaged in a waterproof container. The invoice packing list or bill of lading shall include the NAVSHIPS number of the manual, the quantity and shall indicate which container includes the manuals.

5.1.3 Bulk shipment. - Manuals shipped in bulk shall not be individually wrapped. Containers shall comply with the Uniform Freight Classification Rules or other carrier regulations as applicable to the mode of transportation.

5.2 Marking. - On bulk shipments, interior packages and exterior shipping containers shall be marked with the following information for each item enclosed, except for shipment of an individual copy or an individual set of manuals:

Box (number) of (number) (to be listed on multiple container shipments)
NAVSHIPS number (manual number)
Quantity (in package)

The words "FOR STOCK" shall be endorsed on the package or packages destined for stock, unless otherwise specified. NAVSHIPS numbers shall be indicated on the shipping documents. When a contract or order requires requisitions having different NAVSHIPS manual numbers, the stock copies of each manual number shall be shipped separately.

6. NOTES

6.1 Ordering data. - Equipment specifications and procurement documents shall specify the following:

(a) Title, number and date of this specification.
(b) Quantity of manuals or APH pages required, delivery date and delivery destinations (see 3.7 through 3.11 inclusive).

6.2 Classes of manuals. - The class of manual need not be specified in equipment specifications or procurement documents. The intent is that the manufacturer shall supply class A manuals for any equipment for which he has received class A manual approval. He shall supply class B manuals wherever he has not been granted class A approval.

6.3 Use of term "Service Manual". - Manuals to this issue of the specification are identified as "Service Manuals", instead of "Technical Manuals" since past use of the word "Technical" tended to denote a comprehensive, expensive, theoretical and engineering document whereas all that is necessary is a document that provides for satisfactory operation, maintenance and repair.

6.4 Elimination of types. - Previous issues of this specification have established different types for manuals. Types have been eliminated from this issue. The content and make-up of each manual should be tailor-made to delineate the particular operation and maintenance procedures required.

6.5 Rights in data. - Wherever unlimited rights in data are not obtained, the manual should eliminate all proprietary information if operation and maintenance suitability is not thereby reduced. If proprietary information is required to be included and only limited rights in data are obtained, a restrictive clause per ASPR Section 9 should be included on the cover of each manual for ready identification.

Notice. - When Government drawings, specifications or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever, and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

Preparing activity:
Navy - Ships
(Project 7610-N0148h)

APPENDIX

10. SCOPE

10.1 This appendix covers the requirements for the production of service manuals.

20. REQUIREMENTS

20.1 Quality. - All manuals furnished will be subject to 35-mm microfilming. Letters, lines and symbols shall be of a uniform contrast throughout the documents. Blurred or smudged printing or drop out of characters or lines shall be cause for rejection of the publication. Characters shall be no smaller than 8 point type.

20.2 Typography. - Preferred typography is set forth in table I. When revisions are made to the basic manual, the typography shall conform as nearly as possible to the original manual.

Table I - Typography for 8-1/2 by 11-inch manual.

Use	Type style and size	Capitalization	Leading	Spacing between units
Security classification A condensed	Gothic 14 pt*	Capitals	6 pt.	
Chapter or section titles	Same type as text	Capitals	6 pt.	48 pt. Following marginal copy, text of illustration 18 pt. Preceding text or illustration
Primary side heads	Same type as text	Capitals	2 pt.	6 pt. Preceding or following text
Subordinate side heads	Same type as text	Capitals	1 pt.	6 pt. Preceding or following text
Figure and table titles	Same type as text	Capitals and lower case	2 pt.	6 pt. Following illustration

*If 14 pt. is not available, next smaller size shall be permitted.

Table I - Typography for 8-1/2-by 11-inch manual - (cont'd)

Use	Type style and size	Capitalization	Leading	Spacing between units
Notes and cautions	Same type as text	Capitals centered	----------	4 pt. Preceding and following text
Warnings	Same type as text	Capitals centered	----------	4 pt. Preceding and following text
Text, table of contents, list of illustrations etc.	Book face (roman) bold 10 pt.	Capitals and lower case	1 pt.	12 pt. Preceding illustration or following figure title 6 pt Preceding or following notes, cautions, warnings
Keys or legends	Book face (roman) italics 8 pt.	Capitals and lower case	1 pt.	6 pt. Preceding figure title or following illustration 12 pt. Preceding text
Parts breakdown listings	Book face (roman) 8 pt.	Capitals and lower case	1 pt.	6 pt. Preceding bottom rule or following headings
Footnotes	Book face (roman) bold 8 pt.	Capitals and lower case	1 pt.	

NOTES

1. It is not the intent of this appendix to qualify the methods or composing equipment to be used, but to specify results required.
2. Leading and spacing may be relaxed where circumstances require such alterations.
3. The above requirements are for type that will reproduce same size. When oversize pages are used, type shall reduce to approximately these sizes.
4. All type specified may be plus or minus 1 point, except that 8 point type shall be the minimum allowable size.

NOTES TO TABLE I (cont'd)

5. The type faces listed below are the most preferred. They are available in linotype or can be closely matched on office composing machines.

Book face (Roman)
Garamond
Modern
Bookman
Tribune News
Times Roman
Antique
Baskerville
Century

6. Type sizes as indicated in the requirements were selected for conservation of space and legibility and should not be changed except:

(a) When oversize pages are prepared.
(b) When unusual copy fitting problems arise.

20.3 Layout. -

20.3.1 Text pages. - The preferred layout of 8-1/2 inches by 11 inches text pages is two columns 20 picas wide and 54 picas deep, making an overall page image size of 42 by 60 picas. The text and illustration areas shall conserve space without lessening clarity or legibility. Blanks and spaces shall be avoided, except on fold-ins, and the first major division of the manual (chapter or section) shall be a new odd page.

20.3.2 Fold-ins. - Fold-in pages shall be used only for diagrams, drawings or charts which cannot be reduced for satisfactory presentation on a single page, or when frequent reference is required from other pages of the book. Aprons are required. When fold-in pages are used, they should be held to a two-page fold-in whenever practicable and shall not exceed an overall length of 84 inches from the binding edge including the apron. The apron may contain information pertaining to the diagram, drawing or chart.

20.4 Form-punching and drilling. - Service manuals shall be prepared in looseleaf form unless otherwise specified or approved. Looseleaf publications and revisions shall be punched for looseleaf binding with three holes one-fourth inch in diameter and four and one-fourth inches center to center (for 8-1/2 by 11 inch pages) or, with such other drilling or punching as specified. Punching of revision pages shall be the same as punching of the original manuals.

20.5 Size. - Suggested sizes for final trim of service manuals follow:

4-3/8 by 6-3/4
8-1/2 by 11

All dimensions are in inches.

20.6 Paper stock. -

20.6.1 Text pages. - Paper stock for text pages shall be as specified in 20.6.1.1 or 20.6.1.2.

20.6.1.1 Lithography. - Paper stock shall be white offset book free from unbleached or ground woodpulp and shall have a substance weight of not less than 100 pounds per 1,000 sheets; basis 17 by 22 inches.

20.6.1.2 Letterpress. - Paper stock shall be equivalent to white super-calendered book containing not to exceed 5 percent unbleached chemical wood or ground woodpulp, the remainder to be bleached chemical woodpulp, and shall have a substance weight of not less than 90 pounds per 1,000 sheets, basis 25 by 38 inches.

20.6.2 Fold-ins. - Paper stock for fold-in pages shall be equivalent to high wet strength lithographic map, free from unbleached or ground woodpulp, and shall have a substance weight of not less than 48 pounds per 1,000 sheets, basis 17 by 22 inches.

20.6.3 Binders. - Binders shall be of plastic or pressboard and shall accommodate looseleaf manuals punched or drilled as specified in 20.4 and shall facilitate insertion of replacement pages. Commercial type fasteners are to be used. Information to be included on the binders shall not be stamped with gold or any other metal foil. Binder colors for unclassified manuals shall be any color except yellow or red. Binders for confidential manuals shall be red. Binders for secret and top secret manuals shall be yellow.

MIL-M-15071D(SHIPS)

MARKING CODE-CC
SECURITY CLASSIFICATION

VOLUME I OF III

NAVY
SEC

NAVY
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NAVY

TITLE OF MANUAL (U)

GROUP CLASSIFICATION MARKING (for classified manuals, See DD254)

SECURITY CLASSIFICATION

Figure 1 - Cover.

NAVSHIPS 000-000
SECURITY CLASSIFICATION

MIL-M-15071D(SHIPS)
VOLUME I OF III

TITLE OF MANUAL (U)

WARNING: This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Sections 793 and 794. The transmission or the revelation of its contents in any manner to an unauthorized person is prohibited by law.

SECURITY CLASSIFICATION

Figure 2 - Title page.

MIL-M-15071D(SHIPS)

Approval Authority shall initiate the applicable letters or correspondence granting approval in conformance with approval procedures.

Remarks space shall be used for necessary comments and the inclusion of information regarding the submission of a manual by minor deviations.

Certification: One of the following certification paragraphs shall be typed in this space, as appropriate.

For Class A manuals covering specific equipments.

It is hereby certified that MANUALS _____ is identical to the basic manual MANUALS _____ approved by the approval date shown above except for the detailed information required for the equipment provided under contract or purchase order _____.

For original Class B manuals.

It is hereby certified that MANUALS _____ to be provided under contract or purchase order _____ has been approved by the approval data shown above.

For identical Class A manuals covering specific equipment and Class B manuals.

It is hereby certified that the manuals to be provided under contract or purchase order _____ are exactly identical to MANUALS _____ approved by authority of approval data shown above.

For Class A manuals covering specific equipment and Class B manuals which have been previously distributed but received minor modification.

It is hereby certified that the manuals to be provided under contract or purchase order _____ are exactly identical to MANUALS _____ approved by the approval data shown above except for the necessary modification as shown in the above remarks space.

NOTE: This page may be typed and duplicated if more economical method and shall be included in [illegible] Class B manuals and copies of final manuals.

24

APPROVAL AND PROCUREMENT RECORD PAGE

APPROVAL DATA FOR: NAVSHIPS _____
NAVSEC OF MANUAL:

APPROVAL AUTHORITY:

OCCUPANT OF PURCHASER OTHER	SHIPS APPLICABLE	QUANTITY OF MANUALS	STATUS OF MANUSCRIPT	BUILDING YARD

REMARKS:

CERTIFICATION: DATE _____

MANUFACTURER'S SIGNATURE
MANUFACTURER'S NAME AND ADDRESS
FEDERAL CODE NUMBER (WHEN OFFICE)

ORDER NO.

Figure 3 Approval and procurement record page

[redacted]

[redacted]

SPECIFICATION ANALYSIS SHEET

Instructions

This sheet is to be filled out by personnel either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Bureau of Ships.

This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost.

Comments and the return of this form will be appreciated.

Fold on dotted lines on reverse side, staple in corner, and send to Bureau of Ships, Specifications and Standardization Branch, Washington 25, D.C.

Specification

Organization	City	State
Contract No.		
Quantity of items procured	Dollar Amount $	

Material procured under a direct Government contract ☐ or a subcontract ☐

1. Has any part of the specification created problems or required interpretation in procurement?
a. Give paragraph number and wording

b. Recommendations for correcting the deficiencies

2. Comment on any specification requirement considered too rigid

3. Is this specification restrictive? If the answer is "Yes", in what way?

☐ Yes ☐ No

4. Remarks (Attach any pertinent data which may be of use in improving this specification. Place this form and papers in an envelope and send to the Bureau

Submitted by (Print name and activity)	Date

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BUREAU OF SHIPS
WASHINGTON 25, D. C.

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EXHIBIT 5

NAVSHIPS 321-0030

Technical Manual

VARIABLE DELIVERY PISTON PUMP

MODEL NUMBER PVV-5020-FC-1-20-R

VICKERS INCORPORATED
WATERBURY PLANT
WATERBURY, CONNECTICUT

VICKERS BOOK NO. N-0334-2A

BUREAU OF SHIPS • NAVY DEPARTMENT • WASHINGTON, D. C.

APPROVAL AND PROCUREMENT RECORD DATA

Addendum No. 1

Basic Approval Data For: Navships 321-0030 (Addendum No. 1)

Approved by: Chief, Bureau of Ships Letter NObs-86916 - SER 632D3-513 of 17 May 1963

CONTRACT	CONTRACT DATE	SHIPS APPLICABLE	QUANTITY OF MANUALS	BUILDING YARD
NObs-86916	7-6-62	AGSS-569	54	BUSHIPS

REMARKS:

Reference - Original Contract NObs-76088 dated 9-8-58
Applicable to AGSS-569

CERTIFICATION: DATE: May 28, 1963

It is hereby certified that the manual NAVSHIPS 321-0030, provided under original contract NObs-76088 and Addendum NObs-86916, has been approved by authority of basic approval data shown above.

VICKERS INCORPORATED

John F. Walrad

John F. Walrad
Certifying Officer

VICKERS INCORPORATED
research and development department

TYPE III
TECHNICAL MANUAL

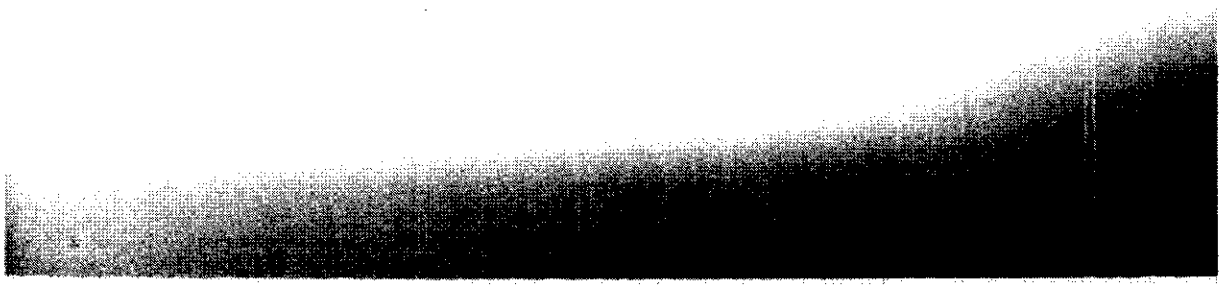
VARIABLE DISPLACEMENT IN LINE HYDRAULIC PUMP

VICKERS INCORPORATED
WATERBURY PLANT
WATERBURY, CONNECTICUT

NOTICE: Additional copies of this or other Manuals may be obtained from the U.S. Naval Supply Depot, 5801 Tabor Avenue, Philadelphia 20, Pennsylvania. Manuals requested on equipment for which a NAVSHIPS identification number is not known may be obtained by furnishing complete identification plate data, service application and other characteristics of the equipment to aid in the identification of the applicable manual.

T. M. No. N1-2789-2B

BUREAU OF SHIPS NAVY DEPARTMENT APRIL, 1963



RECORD OF CORRECTIONS MADE

Pages	Numbers	Date	Signature

TABLE OF CONTENTS

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SECTION 1

DESCRIPTION AND DATA -- GENERAL

This modification is designed to minimize pressure pulsations in the hydraulic circuit. It consists of two capacitance chambers, connected hydraulically to the valve plate, which communicate with each cylinder at the dead center positions to precompress or decompress the cylinder oil. Cylinder pressure is thus matched to port pressure before communication is established, and shock flow is eliminated.

Pump characteristics are left unchanged by this modification except for the following features:

For optimum effectiveness of the capacitance chamber system:

Recommended Operating Speed	1800 RPM
Recommended Max. Operating Pressure	2500 PSI
Physical dimensions and other data needed for installation are shown in Installation Drawing Fig. A-2	
Weight without Oil	580 lbs.

SECTION 2

DETAILED DESCRIPTION

Reference Drawings

Assembly Drawing - Figure A-1

The modifying equipment consists of a large steel accumulator body pc. 23 and associated parts that provide hydraulic communication to the cylinders and the respective ports.

The accumulator body pc. 23 is designed to replace the supporting riser on which the original pump was mounted and to provide two capacitance chambers (accumulators) which serve to precompress and decompress the cylinder oil. The pump proper is bolted and dowelled to the accumulator body, which in turn is bolted and dowelled to the base structure by means of two mounting rails pc. 27.

The accumulator body cover pc. 26 seals one end of the large accumulator. The accumulator orifice body pc. 25 mounts on the other end of the accumulator body and seals both chambers. The orifice body also contains drilled passages to connect the capacitance chambers to the valve plate pc. 22 and to the respective pump ports through the orifice plugs pcs. 28. These orifices are adjustable by means of the adjusting stems pcs. 29, which are locked in position by jam nuts pcs. 5 and acorn nuts pcs. 32.

The accumulator porting block pc. 24 provides drilled passages to connect the pump ports to the accumulator orifice body pc. 25, and smaller passages to connect the accumulator passages to the valve plate. These paths are completed by small holes drilled in the pump head pc. 30.

The special valve plate pc. 22 and cylinder block pc. 21 provide a port pattern to time the communication between the capacitance chambers and the cylinders.

The piston subassemblies pcs. 33 have been modified to reduce the oil volume in each cylinder.

The housing cover pc. 36 has been changed to provide more stiffness and reduce airborne noise.

SECTION 3

INSTALLATION INSTRUCTIONS

Reference Drawings

Installation Drawing - Figure A-2

The instructions given for the original pump all apply unchanged to the modified unit.

The modifying equipment has been designed to replace the supporting riser on which the pump rested. Shaft alignment must be achieved by shimming under the entire assembly, not between the pump and the accumulator body.

The pump will be delivered with the mounting rails attached only by hex cap bolts. This is to permit removal for convenience in mounting to the base structure. After aligning the pump and dowelling the mounting rails to the base, tack weld the rails to the accumulator body to prevent accidental removal.

NOTE

The period of no-load operation required to bleed the air out of the system will be increased considerably for the modified pump because of the large accumulator volumes.

SECTION 4

ADJUSTMENTS

No adjustments should be made on the modifying equipment. The adjustable recharging orifices are set to obtain minimum fluidborne noise in both lines. These adjustments were made in the laboratory under carefully controlled conditions, and the stems were secured with jam nuts and safety wire. These settings should not be changed.

SECTION 5

OPERATING INSTRUCTIONS

Operating instructions given for the original pump all apply unchanged to the modified unit.

The function of each piston as it reciprocates is affected by the capacitance chamber system in the following manner:

At bottom dead center, after completion of the intake stroke and before the discharge stroke begins, the cylinder is opened to the large capacitance chamber (accumulator). High pressure oil from the chamber enters the cylinder, precompressing it to discharge pressure. The cylinder then closes to the capacitance chamber and opens to the discharge port. The capacitance chamber is recharged from the discharge port through the adjustable orifice.

At top dead center the same valve sequence provides for decompression of the cylinder oil into the small capacitance chamber.

A special valve pattern on the cylinder block-valve plate interface accomplishes the required valve sequence with a minimum interruption of the normal cycle.

SECTION 6

MAINTENANCE

Reference Drawings

Assembly Drawing - Figure A-1

All instructions given for the original pump should be followed for the modified unit.

DISMANTLING INSTRUCTIONS

The procedure prescribed for the original pump should be followed and the following amendments observed:

In draining the pump housing, be sure to drain the capacitance chambers as well.

Before dismantling the pump head, remove the accumulator orifice body pc. 25 by removing the 16 socket head screws pc. 1 and 8 socket head screws pc. 7. Then take off the accumulator porting block pc. 24 by removing the two socket head screws pc. 34. Then proceed with dismantling the pump head.

NOTE

This drain connection must be open to atmospheric pressure at all times.

As clean oil is of the greatest importance in maintaining proper operation, the system should be filled only with oil which has been filtered thru a fine wire screen of about 200 mesh.

NOTE

The hydraulic fluid to be used in this unit must conform to MIL-L-17331A, Symbol 2190T.

When starting the pump, start the driving motor by "jogging", i.e. alternately start and stop for a few seconds until the pump primes. The pump should be allowed to operate at no load for a period of time to bleed the air out of the system.

SECTION 4

ADJUSTMENTS

Reference Drawings

Assembly Drawing-Variable Delivery Pump - Figure 3
Installation Drawing-Variable Delivery Pump - Figure 4

The pump is so constructed that no internal adjustments are required. External adjustments have been provided for pump delivery and pressure control.

TO ADJUST THE PUMP DELIVERY

This adjustment consists of an adjusting screw with a handle and a locking device located on the pump head opposite the drive shaft. When the adjusting screw is fully extended the pump will deliver its maximum volume. Turning the adjusting screw "in" will reduce the volume of oil delivered.

TO ADJUST PRESSURE

The adjustment consists of an adjusting screw with a knurled head and a lock nut located on the side of the pump head. With the adjusting screw fully extended, the pressure setting will be at the minimum value. Turning the adjusting screw "in" will increase the pressure. The maximum recommended operating pressure is 5000 PSI.

SECTION 5

OPERATING INSTRUCTIONS

Reference Drawings

Assembly Drawing - Variable Delivery Pump - Figure 3
Figure 1 - Schematic - Pump
Figure 2 - Schematic Pressure Control

The variable delivery pump is of the axial piston type, containing a drive shaft which in operation rotates at a constant speed to drive the cylinder block.

The pump operation is briefly as follows and is shown schematically on figure 1.

The multiple cylinder block (c) supported and rotated by the drive shaft (f) contains nine (9) pistons (a). At the ends of the pistons are attached shoes (b) which form a seat for the ball end of the pistons. These shoes are mechanically held against the thrust plates (e) by the slipper plate (h), the ball sleeve (g) and spring (j). The cylinder block (c) is held against the valve plate (d) by spring (j). The thrust plate (e) is retained by a movable yoke, which swivels to change the angle (a). The actual construction is shown on assembly drawing Ref. Drg. Figure 3.

With the pump yoke at center or zero stroke position, as shown in Figure 1-Z, the cylinder block and drive shaft revolve around a common axis without producing relative motion between the cylinder block and the pistons. As the pump yoke is moved from its center position as illustrated in Figure 1-X, a relative reciprocation of each piston in its cylinder occurs. Each piston thus functions in succession to cause suction during one-half revolution of the cylinder block, as its cylinder fills with oil admitted thru the semi-circular port in the valve plate and then discharges while the cylinder block revolves through the second half of the revolution.

The length of stroke of each piston and resultant volume of discharge depends upon the angle formed between the thrust plate and the drive shaft axis. Actually, the volume of oil discharged from each cylinder is in direct proportion of the size of this angle, thus an infinite range of delivery up to the maximum rated capacity can be obtained by varying the angular position of the thrust plate.

The basic pump can be operated either side of center, however, when pressure controls are used, the pump yoke will only operate one side of center, as indicated on Figure 2 which shows schematically the pressure control.

When the pump is operating at low pressure below the pressure setting of the pressure control valve, piston (a) and its spring holds the pump yoke on its maximum stroke. As the pressure increases, oil is delivered from the main pressure line to port (c) of the pressure control valve sleeve. Oil flows around the sleeve through the small hole (e) to the differential chamber (g) of the valve spool. This differential area acts against spring (f) causing the valve spool to compress its spring which has been preset to the desired operating pressure. Movement of the valve spool ports pressure oil from chamber (g) through port (d) to the pistons (b) which act to reduce the pump stroke and the subsequent pump delivery.

Rapid movement of the pump yoke is achieved by a further small movement of the valve spool, to port pressure oil from the port (c) past the valve spool land direct to chamber (g) and there to the pistons (b). As the pressure is reduced, spring (f) moves the valve spool to cut off the supply of main pressure oil to pistons (b) and opens these pistons to the pump drain by porting the trapped oil through port (d), past the spool land, and through hole (h) in the valve spool to the center of the valve spool and there to the drain line. Main circuit pressure effective on piston (a) returns the pump on stroke. As the seal between the valve spool land and port (d) is very small, the control is very sensitive to pressure changes.

The yoke limiting control is an adjustable stop which can be manually set to control the stroke of the pump from zero delivery to the max. rated capacity of the pump.

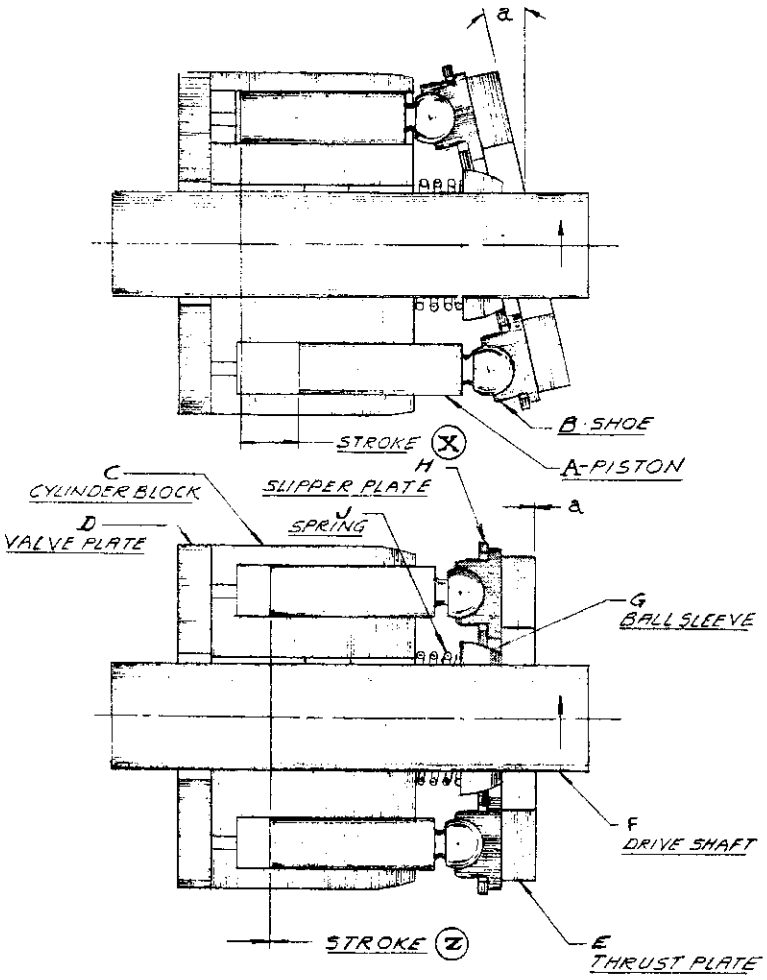


Figure 1 Schematic — Shows how angle of tilt affects stroke

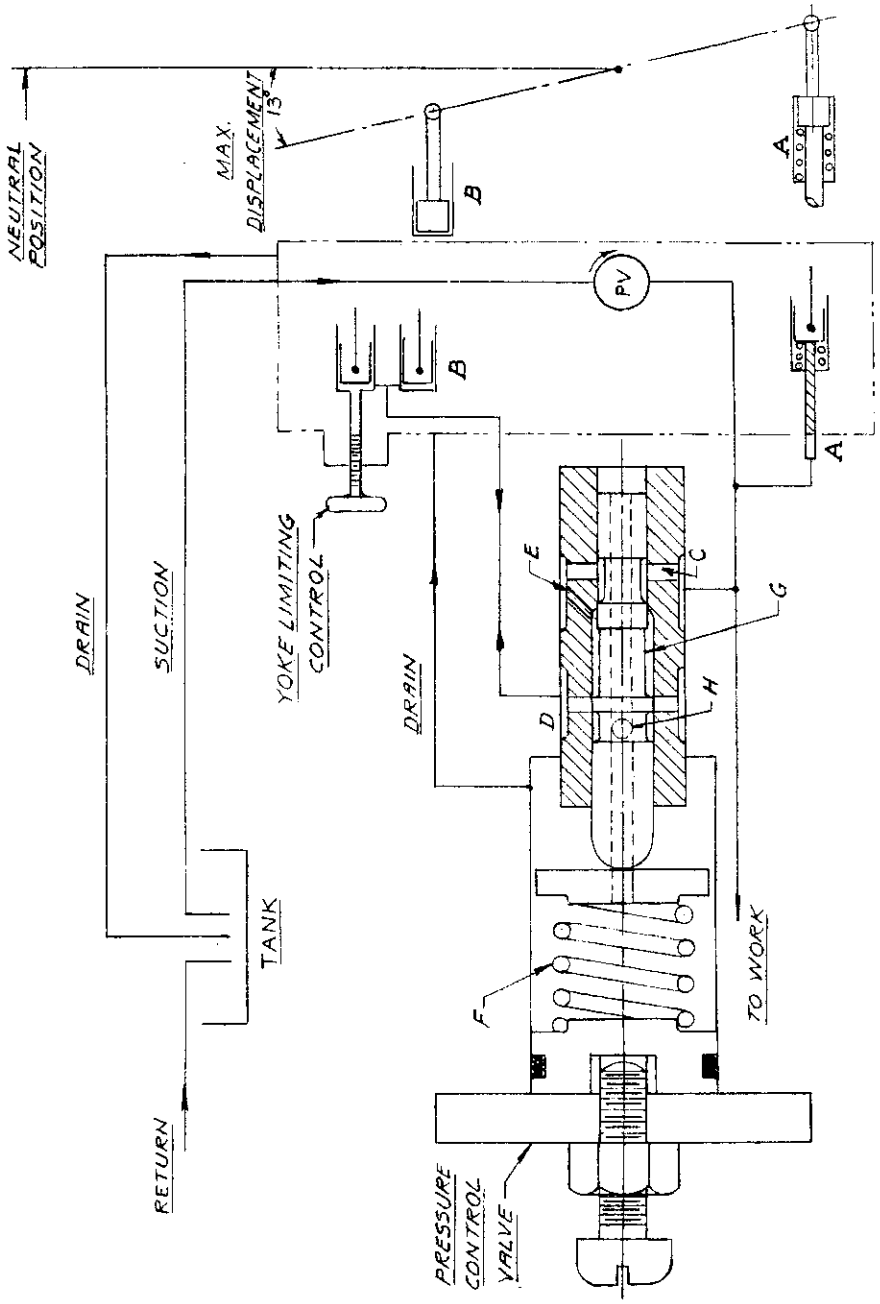


Figure 2 Schematic-Pressure Control Valve

SECTION 6

MAINTENANCE

Reference Drawings

Assembly-Variable Delivery Pumps - Figure 3

GENERAL INSTRUCTION

These pumps have been designed to give the most efficient and satisfactory service possible. Their component parts have been manufactured with the greatest precision of workmanship. Ample provisions have been incorporated for the lubrication of all moving parts which are suitably housed to prevent dirt or other injurious substances from coming in contact with these parts. However, the efficiency and life of the pump will depend largely upon the care with which it is installed and the attention to oil cleanliness it receives in service. If dirt or other foreign matter is allowed to get into the hydraulic system, it will have a detrimental effect on the enclosed mechanism. It will tend to impede the movement of the pistons, obstruct small orifices and have a general abrasive effect on all moving parts.

When working on the pumps, care must be taken to prevent dirt, metal chips or filings from getting into the system. When the equipment is opened for repairs, any exposed parts should be covered with a clean tarpaulin before leaving them for the night.

All oil must be strained through a fine No. 200 mesh wire screen as it is poured into the system. The use of cloth strainers is not recommended since the continued use of such material tends to cause an accumulation of lint in the systems. This may result in the sticking of pistons and valves.

When the pump is drained after being in service, all dirt and sludge must be cleaned out and the pump flushed with acid-free cleaning fluid. Before refilling with oil after the flushing process, all cleaning fluid must be removed and the pump blown out with clean air until dry. Unless this is done, either the chemical or the physical properties of the oil may be impaired by small quantities of cleaning fluid.

Water in the pump may cause trouble because of its corrosive action on unprotected internal metal parts. It may also cause trouble by freezing in cold weather.

Hydraulic equipment which has been standing idle at extremely low temperatures should be started with care. While the oil is pumpable at low temperatures, it is very viscous. A short time is required to force the oil between closely fitted parts so as to provide lubrication. Two or three minutes of operation at low pressures will provide ample time for penetration. During this time the oil will warm up and its viscosity will be greatly reduced.

Whenever the hydraulic system has been drained and filled, the following instructions must be observed in order that all air in the hydraulic system be removed.

1. Start the driving motor by "jogging", i.e. alternately start and stop for a few seconds.

2. Allow the pump to operate at no-load for a period of time to allow air to bleed out.

3. Check the system oil level and add oil if necessary.

The circulating oil in the hydraulic system should be completely drained, flushed, and refilled with fresh oil periodically, depending on the pump location, actual running time and the cleanliness of the surroundings. Flushing should be performed with a light mineral oil.

Periodic inspection or overhaul of the pump normally will not be required, but in the event that it is dismantled, all parts should be inspected for excessive wear or deformation and replaced where necessary.

LUBRICATION INSTRUCTIONS

All moving parts of this pump are self-lubricated by the hydraulic fluid being circulated by the pump, except for the shaft seal pc. 82 which was packed with grease at the factory and requires no further lubrication.

TROUBLE DIAGNOSIS AND CORRECTION

The following chart may be of use in locating the source of an operating difficulty affecting the operation of this piston pump.

TROUBLE DIAGNOSIS CHART

TROUBLE	CAUSE	REMEDY
Pump not delivering oil.	Wrong direction of shaft rotation.	Reverse the direction.
	Tank or system oil level low.	Add recommended oil. Be certain oil is reaching pump inlet.
	Pressure control not functioning properly.	Clean and check pressure control.
	Volume control set at zero stroke.	Adjust volume control.
Pump not developing pressure	Pump not delivering oil for any of the above reasons.	Same as above.
	System relief valve set too low.	Check relief valve setting.
	Pressure control setting too low.	Adjust pressure control. (See adjustments)

TROUBLE	CAUSE	REMEDY
	System relief sticking open due to dirt.	Disassemble and clean thoroughly.
	Driving motor not rotating pump.	Check power supply.
Pump making noise.	Partly clogged intake line, intake filter or restricted intake pipe.	Remove restriction.
	Air leak at pump intake lines.	Pour oil on joints to locate leak and then tighten.
	Pump running too fast.	Check and correct.
	Coupling (prime mover to pump) misaligned.	Realign and replace pump shaft seal.
	Oil viscosity too high.	Use correct oil.
Excessive wear of pump rotating parts	Abrasive matter in system oil.	Drain oil, flush, and refill with new clean oil.
	Coupling misalignment.	Correct and replace pump shaft oil seal.

DISMANTLING INSTRUCTIONS

All units are tested under actual operating conditions at the factory prior to shipment. Therefore, if anything appears to be wrong with the operation, it is suggested that other sources of trouble be checked before the pump is dismantled. However, if it becomes necessary to take the pump apart for any reason, the following procedure should be followed.

Relieve pressure throughout the complete hydraulic unit and drain all lines to reservoir.

The pump should be removed from its mounting by removing all piping, mounting screws and couplings and should be placed on a clean bench for convenience for disassembly. Cap open lines to prevent contamination of the hydraulic fluid. Next, drain the pump housing. Be sure to expel fluid from the cylinder bores and internal passages by turning the drive shaft manually.

The pump head pc. 102 should first be dismantled by removal of the seven socket head screws pc. 17 and the two screws pc. 25 which also secure the plunger retainer pc. 95. The pump head with the roller bearing pc. 44 can be slipped off the end of the drive shaft pc. 51. The valve plate pc. 107 may come out of its chamber with the pump head. If not, tapped holes have been provided in the valve plate for the use of jack screws for withdrawing the valve plate. Usually the cylinder block pc. 13, with its component parts, will be withdrawn with the valve plate. If not, tilting the pump at an angle will permit the cylinder block to slide out of the housing pc. 6 far enough to make it accessible for withdrawal.

CAUTION

Care must be exercised not to drop the cylinder block, which would severely damage the lapped face of the cylinder block or the cylinder bores.

After withdrawal of the cylinder block it should be carefully placed on a clean surface with the piston rod end up. The piston pc. 3, the slipper plate pc. 49, the ball seat pc. 50 and ball sleeve pc. 77 can be removed from the cylinder block. The three straight pins pc. 75 can be lifted out. The removal of the sealing spring pc. 65 should be accomplished by the use of an arbor press to compress the spring to allow removal of the internal retainer ring and the remaining spring retainer parts.

The removal of the eight hex head screws pc. 18 will allow the withdrawal of the pump housing cover pc. 97 along with the drive shaft pc. 51 bearing pc. 64 and retainer pc. 79 as a component. The shaft and bearing assembly can now be tapped out of the housing cover. Support the bearing at the inner race on an arbor press and force the shaft through the bearing pc. 64.

CAUTION

The bearing must be removed or assembled from the splined end of the shaft so that the bearing will never be forced over the shaft seal surface. This method of assembly or dismantling will prevent damage occurring to the shaft oil seal surface.

The pump yoke pc. 101 can next be removed from the pump housing. With the pump housing resting on its mounting feet, remove the upper set screw pc. 70 located at the yoke pin bores. Next, tighten the lower set screws enough to break loose the tapered lock pin pc. 63. Now, removing the lower set screws and using a punch, the lock pins can be easily removed. The yoke pins pc. 80 can be withdrawn from the housing by using the tapped holes located at the end of the pins for use of "Jack" screws. The thrust ring pc. 48 can now be lifted off its two dowel pins pc. 21 and lifted out of the yoke. The push rods pc. 55 can be dismantled from the yoke by the removal of the push rod clamps pc. 99 and pc. 100. Tapped holes have been provided in the ends of the regulating pistons pc. 52 and also the yoke actuating pistons pc. 56 to provide for "Jack" screws for easy dismantling and assembly.

The indicator dial gear pc. 57 can be dismantled by the removal of the lock nut pc. 34 from the end of the indicator dial gear, and then using a screw driver, the indicator pc. 45 can be pried off its shaft.

The pressure regulating valve can be easily dismantled after removing its cover pc. 86, however, care must be exercised that the spring pc. 83 does not fly out of its housing when removing its cover. The valve sleeve pc. 62 which has a light press fit may be easily removed by inserting a "Jack" screw through the sleeve into the tapped sleeve washer. Turning the "Jack" screw will force the valve sleeve out of its housing.

Further dismantling of the pump should be evident by examination of the assembly drawing Ref. Drg. Fig. 3.

ASSEMBLY INSTRUCTIONS

After the components of the pump have been thoroughly washed, cleaned, inspected and repaired they should be rinsed in clean hydraulic fluid prior to reassembly. All "O" Rings should be renewed. Apply a thin film of hydraulic fluid to the "O" Rings before installing them in a unit.

Generally, reassembly of parts may be performed in reverse order to the dismantling procedure, however, the few following assembly methods should be observed.

When reassembling the pump yoke into the housing, insert the first yoke pin pc. 80 only a short distance into its roller bearing pc. 44 and then line up the other pin. These pins should be well lubricated with clean oil and turned manually into position.

CAUTION

Do not force these pins into place as the roller bearing may be damaged in so doing.

The yoke pins pc. 80 are to be assembled from the top, making sure the slot in the lock pin lines up with the tapped hole in the housing. Next, assemble the top set screw pc. 70 tightly into position to force the tapered portion of the lock pin pc. 63 into the groove of yoke pin pc. 80. These parts may then be locked into position by inserting and tightening the lower set screw.

At this time, it will be necessary to reassemble the volume indicator mechanisms, the correct position of which is determined by the meshing of the indicator gear pc. 57 with the gear segment attached to the yoke. There is a notch in the yoke to permit insertion of the indicator gear pc. 57 into the pump housing when the yoke is rotated into a position, so that the notch is aligned with the hole for the indicator gear. The weight of the yoke will normally place it in a full stroke position determined by the yoke contacting the assembled housing cover pc. 97. With the yoke in this position, the volume indicator pointer must be assembled on its shaft so as to point to the figure 4 on the lower segment of the indicator dial pc. 46. This is opposite to the position of the yoke and the volume indicator as shown on the assembly drawing, but this method described should be used to facilitate assembly. When the pump is completely assembled, it will agree with the drawing.

All cylinder block components should be assembled before attempting to replace the cylinder block in the pump. The following procedure should be used. First, assemble the retainers and spring pc. 65 into its chamber using an arbor press to compress the spring. Next, insert the three straight pins pc. 75 and place the ball sleeve pc. 77 on top of the cylinder block in contact with the three straight pins. Place the ball seat pc. 50 and the slipper plate pc. 49 over the ball sleeve. The subassemblies of the pistons and shoes pc. 1 can now be assembled through the slipper plate and into the cylinder bores.

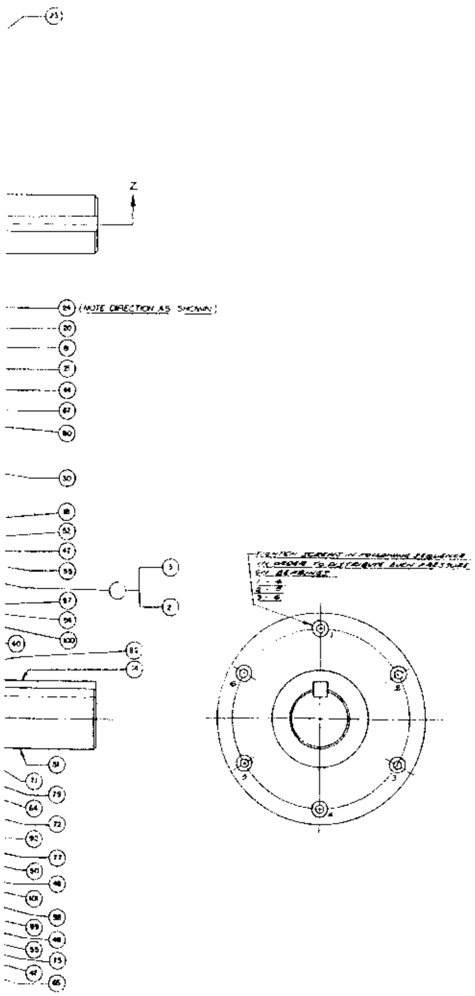
CAUTION

Do not force the pistons into their bores because if they are correctly entered into the bore, they will slide in easily.

After the cylinder components have been correctly assembled and the thrust ring pc. 48 replaced in the yoke, over its dowel pins pc. 21, the cylinder sub-assembly should be carefully fed over the end of the assembled drive shaft pc. 51 and slipped into place with the piston shoes contacting the thrust ring pc. 48.

When reassembling the two regulating pistons pc. 52 and the yoke actuating piston pc. 56, care must be taken that they be assembled in their correct respective locations. The only physical difference in these three pistons is that the yoke actuating piston pc. 56 has a drilled and tapped hole through the piston for the use of a "Jack" screw, and is also used for a drain connection for the spring chamber. The other two pistons have a "blind" drilled and tapped hole for the "Jack" screw use only. If these pistons are assembled in the wrong location the pump will malfunction as main circuit oil will be directed to the pump case through the open drilled hole, and no pressure oil will be available for shifting the pump yoke.

When mounting the pump head, care must be used not to damage the roller bearing pc. 44 located in the pump head. The accepted method of doing this is to carefully enter the end of the pump shaft into the roller bearing and to manually push the pump head tightly against its mounting face before attempting to tighten any of the mounting screws. This method of assembly will insure correct bearing assembly.



LIST OF MATERIAL QUANTITIES FOR ONE PISTON PUMP ASSEMBLY

PC NO	NAME OF PIECE	NO REQ	MATERIAL	MATERIAL SPEC	DRAWING NO
37	TOP RING	1	SYN. RUBBER	MIL-P-5516	B-154009
38	TOP RING	1	SYN. RUBBER	MIL-P-5516	B-154010
39	TOP RING	3	SYN. RUBBER	MIL-P-5516	B-154020
40	TOP RING	1	SYN. RUBBER	MIL-P-5516	[illegible]
41	TOP RING	1	SYN. RUBBER	MIL-P-5516	B-154130
42	TOP RING	1	SYN. RUBBER	MIL-P-5516	B-154131
43	TOP RING	1	SYN. RUBBER	MIL-P-5516	B-154131
44	BEARING	2	STEEL	FF-B-185	B-164206
45	INDICATOR	1	SAE 70 BRASS	QQ-B-611 COMP. C	B-164730
46	DIAL	1	SAE 70 BRASS	QQ-B-611 COMP. C	C-164546
47	WASHER - PLAIN	1	STEEL	MIL-S-16788	B-164640
48	RING - THRUST	1	STEEL	QQ-S-00778 FS-42	C-164793
49	PLATE - SLIPPER	1	STEEL	MIL-S-7493 COMP. 4615	C-164796
50	SEAT - BALL	1	SAE 48 BRONZE	AMS-4870	C-164797
51	SHAFT - DRIVE	1	STEEL	MIL-S-5626	B-820039
52	PISTON - REGULATING	2	CAST IRON	QQ-I-00652 CL. 40	C-164879
53	FLANGE - INLET	1	STEEL	QQ-S-633, FS 1018	C-164882
54	SEAT - PUSH ROD	6	BRONZE	COMMERCIAL	B-164912
55	ROD - PUSH	3	STEEL	QQ-S-633 FS-1117	B-164910
56	PISTON - REGULATING	1	CAST IRON	QQ-I-00652 CL. 40	C-164915
57	GEAR-DIAL INDICATOR	1	STEEL	QQ-S-634	C-164927
58	GEAR SEGMENT-DIAL INDICATOR	1	STEEL	COMMERCIAL	B-164950
59	SPRING	1	MUSIC WIRE	QQ-W-470	B-177580
60	PISTON - ADJUSTING SCREW	1	STEEL	QQ-S-633 FS-1117	B-168156
61	SPOOL - VALVE	1	STEEL	MIL-S-7493 COMP. 4615	C-169157
62	SLEEVE - VALVE	1	STEEL	MIL-S-7493 COMP. 4615	C-169158
63	PIN - LOCK	2	STEEL	QQ-S-633 FS-1018	B-169193
64	BEARING-N.D. 45330 B K 14	1	STEEL	FF-B-171	B-820038
65	SPRING - PRESSURE	1	STL. WIRE	QQ-W-470	C-169913
66	RING	1	STEEL	QQ-S-633, FS 1065	B-169933
67	TOP RING	2	SYN. RUBBER	MIL-P-5516	B-169934
68	RING - SNAP	3	STEEL	QQ-S-633, FS 1065	B-169945
69	GUIDE - SLEEVE EXTRACTOR	1	STEEL	MIL-S-16410	B-170034
70	SCREW - SET - FLAT POINT	4	SAE 3130 STL.	MIL-S-890 AL. 2	B-170171
71	RING - RETAINER	2	STEEL	QQ-S-633, FS 1065	B-170177
72	SCREW	8	SAE 1035 STEEL	QQ-S-634, FS 1035	B-1080
73	PIN - ROLL	2	SAE 1095 STL.	MIL-S-16410	B-172750
74	KEY - 3/4 IN.	1	STEEL	MIL-S-16410	B-177976
75	PIN-BALL, SLEEVE PRESSURE	3	STEEL	QQ-S-633 FS-1018	B-178729
76	SPRING RETAINER	1	STEEL	QQ-S-633 FS-1018	B-178732
77	SLEEVE - BALL	1	STEEL	MIL-S-7493 COMP. 4615	C-178734
78	EYE BOLT	1	STEEL	MIL-S-16788	B-178758
79	ATTACHER - BEARING	1	STEEL	QQ-S-633 FS-1117	C-401037
80	PIN - YOKE	2	STEEL	MIL-S-7493 (4620)	B-179128
81	PLATE - NAME	1	ALUMINUM	QQ-A-561	B-179284
82	SEAL - SHAFT	2	MFG. STD.	COMMERCIAL	B-AE-179311
83	SPRING - COMPRESSION	1	SPRING STEEL	QQ-W-414	C-179498
84	SEAT - SPRING	1	STEEL	QQ-S-633 FS-1117	B-179520
85	RETAINER	1	STEEL	QQ-S-633 FS-1018	B-179531
86	COVER - REGULATING VALVE	1	STEEL	QQ-S-633 FS-1018	B-179532
87	SEAT	1	STEEL	QQ-S-633 FS-1117	B-179591
88	SCREW-PRESSURE REGULATING	1	STEEL	QQ-S-633 FS-1117	B-179592
89	PLUNGER - YOKE ACTUATING	1	STEEL	MIL-S-7493 Comp. 4615	B-181085
90	SLEEVE - DOWEL	2	AMS 6317	QQ-S-633, FS 1117	B-183455
91	PLUG-AN HYDRAULIC (SAE)	1	STEEL	QQ-S-634	B-187587
92	SPACER	1	STEEL	COMMERCIAL	B-820046
93	SPRING - YOKE ACT. (SMALL)	1	SPRING STEEL	QQ-W-414	C-190236
94	SPRING-YOKE ACT. (LARGE)	1	SPRING STEEL	QQ-W-474	C-190237
95	RETAINER	1	STEEL CAST	MIL-S-15083 (CL. 070)	C-190259
96	BUSHING-YOKE ACT.-PLUNGER	1	STEEL	MIL-S-7493 COMP. 4615	B-190263
97	COVER - PUMP HOUSING	1	DUCTILE IRON	MIL-I-17166 A	E-820098
98	SCREW - FILL. HD.	6	STEEL	MIL-S-16788	B-190288
99	CLAMP - ROD PISTON	1	STEEL	QQ-S-633 FS-1018	B-190291
100	CLAMP - ROD PISTON	1	STEEL	QQ-S-633 FS-1018	B-190291
101	YOKE	1	STEEL CAST	MIL-S-6758	F-190302
102	HEAD	1	STEEL CAST	MIL-S-6758	B-190312
103	TOP RING	2	SYN. RUBBER	MIL-P-5516	B-190323
104	TOP RING	1	SYN. RUBBER	MIL-P-5516	B-190308
105	TOP RING	2	SYN. RUBBER	MIL-P-5516	B-190365
106	FLANGE - OUTLET	1	STEEL	QQ-S-633 FS-1018	C-190513
107	PLATE - VALVE	1	STEEL	QQ-S-00778 FS-AE	E-[illegible]

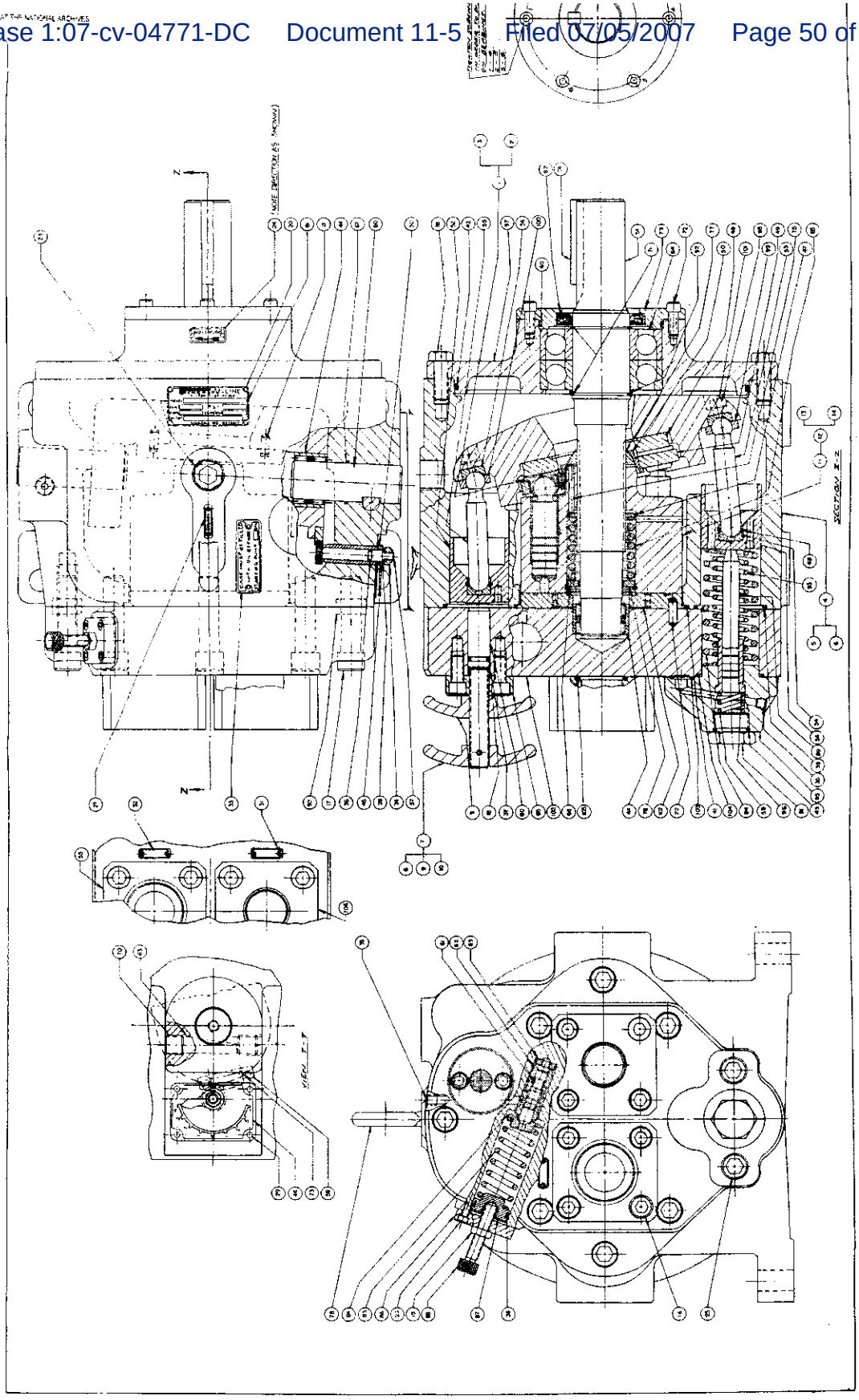
LIST OF MATERIAL QUANTITIES FOR ONE PISTON PUMP ASSEMBLY

PC NO	NAME OF PIECE	NO REQ	MATERIAL	MATERIAL SPEC	DRAWING NO	REMARKS
1	SUB-ASSEM. - PISTON & SHOE CONSISTS OF P.C. 2 & 3	9			C-168791	
2	1-SHOE - PISTON	9	COPPER ALLOY	COMMERCIAL	C-168789	NOTE - 1
3	1-PISTON	9	STEEL	MIL-S-7493 COMP. 4615	C-168790	
4	SUB-ASSEM. HOUSING & BUSHING PC. NO. 5 & 6	1			C-173996	
5	1-BUSHING	4	BRONZE	QQ-B-691 COMP. 12	B-556962	
6	1-HOUSING	1	CAST IRON	QQ-I-00652 CL. 40	A-179458	
7	SUB-ASSEM. - ADJUSTING SCREW CONSISTS OF PC. 8, 9 & 10	1			B-169794	
8	1-SCREW	1	SAE 1112 STL.	MIL-S-18411	B-169797	
9	1-HANDLE	1	CAST IRON	QQ-I-00652 CL. 30	C-169061	
10	1-PIN-ROLL	1	SAE 1095 STL.	MIL-S-16410	B-172468	
11	SUB-ASSEM. CYLINDER BLOCK CONSISTS OF PC. 12-14	1			D-189961	
12	1-SUB-ASSEM.-CYLINDER ALY & BUSH.-CONSISTS OF PC. 13 & 14	1			C-189950	
13	1-BLOCK-CYLINDER	1	STEEL	QQ-S-624 FS-4137	D-189960	
14	9-BUSHING	9	COPPER ALLOY	COMMERCIAL	B-189957	NOTE - 1
15	SCREW - SOC. H.D. CAP.	2	SAE 3135 STL.	MIL-S-890 AL. 2	B-1971	
16	SCREW - SOC. H.D. CAP.	8	SAE 3135 STL.	MIL-S-890 AL. 2	B-1116	
17	SCREW - SOC. H.D. CAP.	4	SAE 3135 STL.	MIL-S-890 AL. 2	B-1158	
18	SCREW - HEX. H.D. CAP.	8	SAE 3135 STL.	MIL-S-890 AL. 2	B-1393	
19	NUT-HEX. FL. [illegible]	1	STEEL	MIL-S-16787	B-1408	
20	SCREW - DRIVE	14	STEEL	FF-S-107 [illegible]	B-1725	
21	PIN	2	DRILL ROD	COMMERCIAL	B-2821	
22	PIN-DOWEL	1	SAE 1117 STL.	QQ-S-633 FS 1117	B-3015	FOR PROCUREMENT [illegible]
23	PLUG - 1/4 HYDRAULIC	1	SAE 8622 STL.	QQ-S-624	B-7370	
24	PLATE - ROTATION	1	SAE 70 BRASS	QQ-B-650 COMP. C.	B-7443	
25	SCREW - SOC. H.D. CAP	3	SAE 3135 STL.	MIL-S-890 AL. 2	B-7781	
26	SCREW - SOC. H.D. CAP	4	SAE 3135 STL.	MIL-S-890 AL. 2	B-9958	
27	PLATE - DRAIN	1	SAE 70 BRASS	QQ-B-650 COMP. C	B-27927	
28	WASHER - PLAIN	1	STEEL	FF-W-92	B-27761	
29	SCREW - DRIVE	4	STEEL	COMMERCIAL	B-47189	
30	WASHER - PLAIN	1	STEEL	FF-W-92	B-51977	
31	PLATE-PORT INDICATOR (OUTLET)	1	BRASS	QQ-B-650 COMP C	B-57817	
32	PLATE-PORT INDICATOR (INLET)	1	BRASS	QQ-B-650 COMP C	B-57818	
33	PLATE - INSTRUCTION	1	ALUMINUM	QQ-A-561	B-70664	
34	NUT - LOCK	1	STEEL	COMMERCIAL	892672	ANACONDA [illegible]
35	PLUG - 1/16 HYDRAULIC	1	SAE 8622 STL.	QQ-S-624	B-113008	PUR. FROM [illegible] STEEL CO.
36	TOP RING	1	SYN. RUBBER	MIL-P-5516	B-118604	

NOTE - 1
CHEMICAL ANALYSIS FOR COPPER ALLOY (MUELLER 6-1)
COPPER........................[illegible]
MANGANESE....................[illegible]
SILICON.......................[illegible]
LEAD..........................[illegible]
ALUMINUM.......................0.50 MAX.
IRON...........................0.50 MAX.
OTHER ELEMENTS, TOTAL..........0.50 MAX.
ZINC...........................BALANCE

MASTER DRAWING
ASSEMBLY "V" LINE PISTON PUMP

FIGURE 3



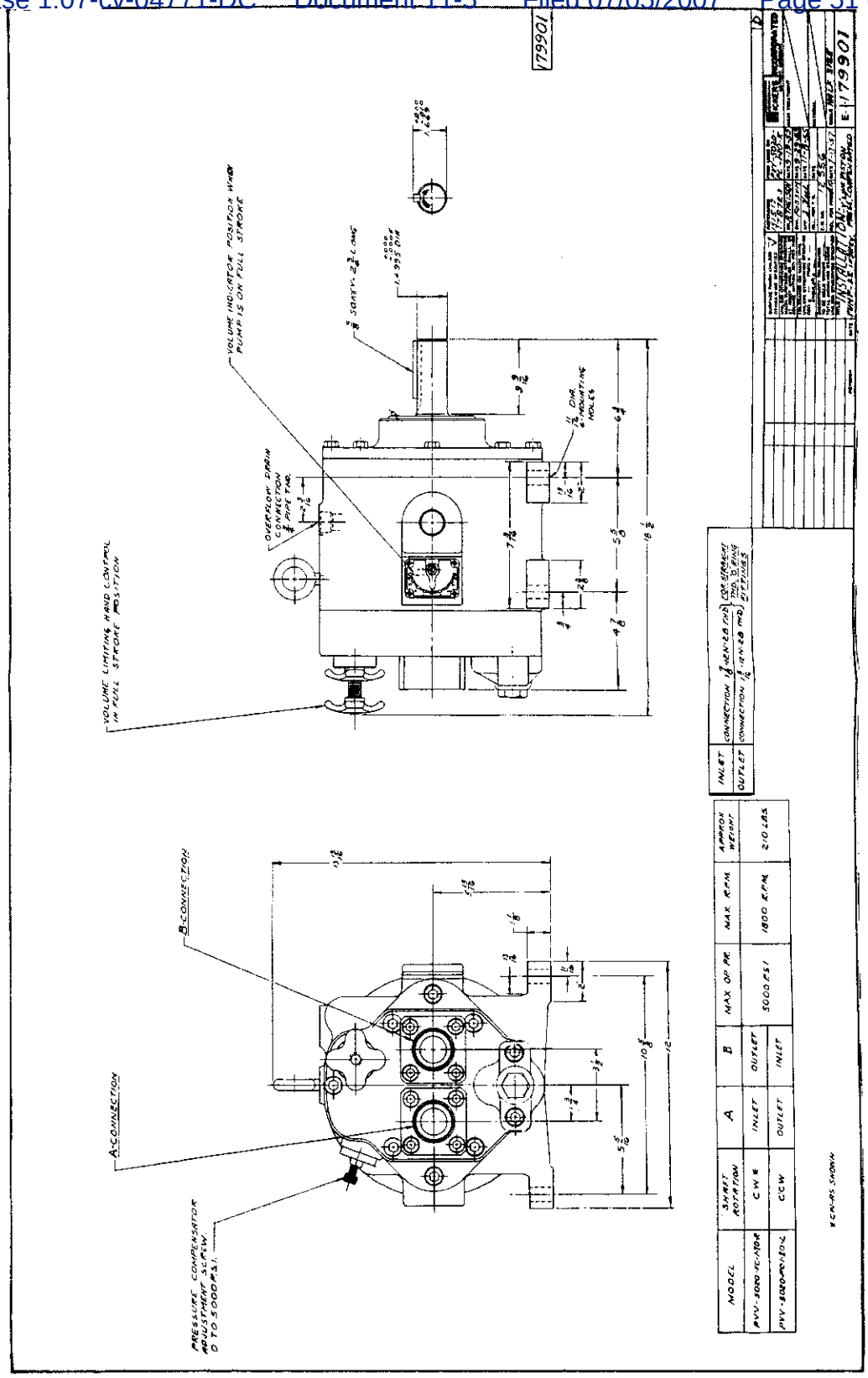


FIGURE 4
INSTALLATION "V" LINE PISTON PUMP